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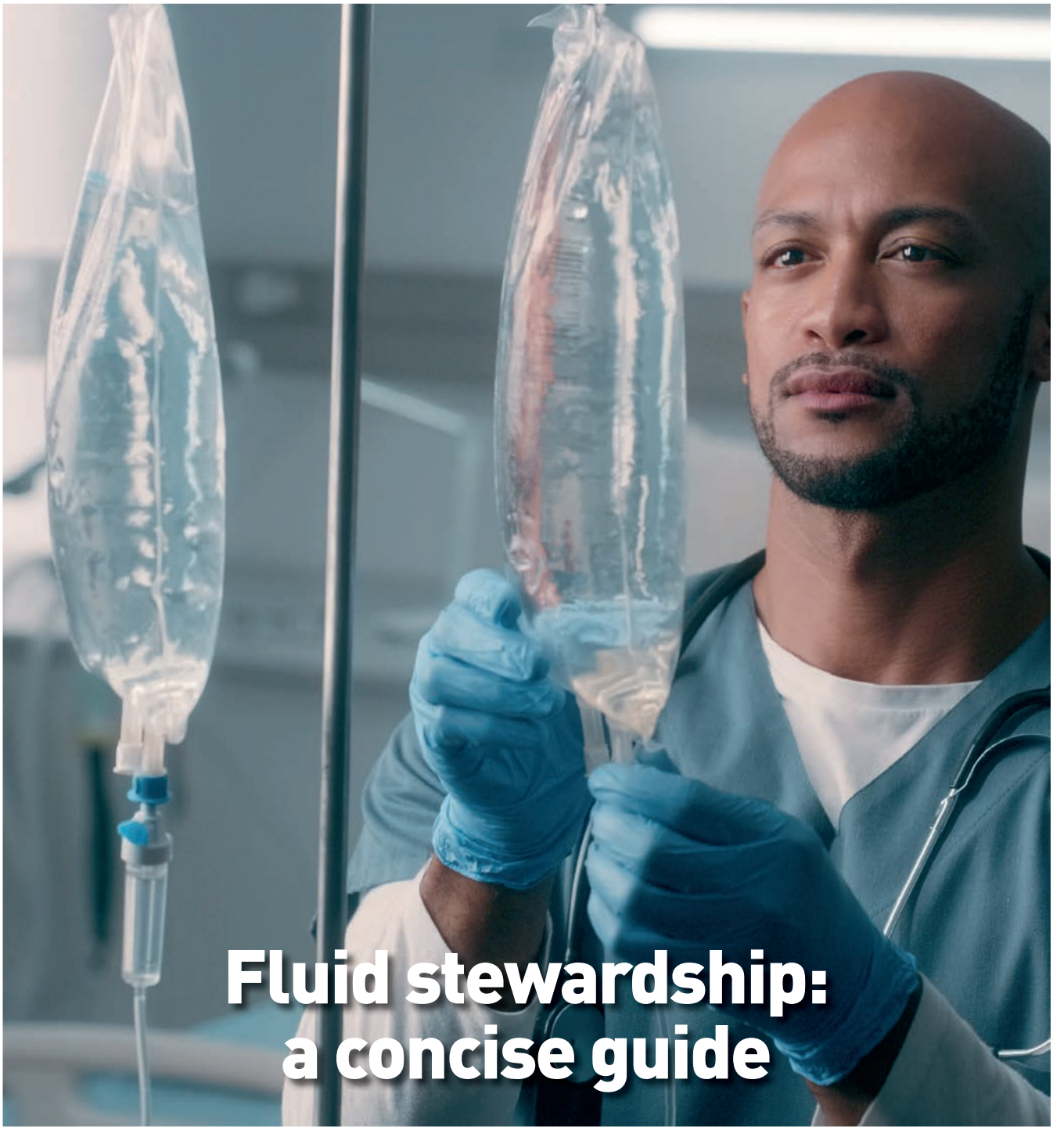
HANDBOOK



Fluid stewardship: a concise guide

Content Director, Secondary Care
Andrea Porter

Artwork/design assistance
Stephen Powell

Business Development Director
Neil Morris

Commercial Director, Secondary Care
David Ling

Executive Director
Edward Burkle

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1 Giltspur St, London, EC1A 9DD, UK.
T +44 (0)20 7214 0500
F +44 (0)20 7214 0501
E hpe@cogora.com
W cogora.com

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Foreword

Hospital Pharmacy Europe has had the pleasure of working with a distinguished faculty of experts to bring you our handbook to educate on fluid stewardship.

Despite the recognised importance of fluid management, inappropriate use remains a significant issue in many organisations. Clinicians and pharmacists from the EU and the UK have therefore shared their expertise on the principles of fluid stewardship and how this expedites judicious use.

Our concise educational handbook outlines what fluid stewardship entails, its aims and objectives, and how pharmacists are well positioned to implement best practice strategies for ensuring prudent and appropriate fluid prescribing.

Professor Robert Hahn opens the handbook with an overview of the fundamentals of fluid prescribing, the types of fluids used and the rationale behind the various formulations employed in different circumstances. He emphasises the importance of healthcare professionals understanding the principles of administering fluids and how ongoing reassessment is needed for continuing this treatment.

In the second section of the handbook, Stephanie Wuyts and Professor Pieter Cornu explain fluid stewardship from the perspective of hospital pharmacy. They discuss the core principles, the key stakeholders involved in establishing these initiatives and the benefits of these programmes for hospital and patient outcomes.

Professor Manu Malbrain then reviews best practice strategies, including the 10D framework, which provides a systematic approach to fluid management to implement at the bedside. This framework addresses misconceptions about fluid therapy, such as the assumption that all patients with sepsis are hypovolaemic or that fluid responsiveness always necessitates administration.

He stresses how intravenous fluids are frequently perceived as harmless but how they should be acknowledged as medications that necessitate careful consideration of indications, contraindications, potential complications and adverse effects.

Building on these best practice strategies, Alan Timmins concentrates on implementing and mandating change, emphasising that fluid stewardship can be viewed as an ongoing quality improvement programme. Before launching a fluids programme, considerable preparatory work is required to clarify its implications for the organisation and appointing a clinical lead is crucial to secure executive buy-in. Targeted education is also essential to ensure that those prescribing or administering fluids comprehend what will make a difference, with the pharmacist ideally positioned as part of the multidisciplinary team to provide this learning.

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Pharmacists oversee fluid supplies to clinical areas, so are also ideally placed to implement usage review programmes. They can also monitor treatment costs and look to minimise unnecessary use and therefore waste.

Finally, a case study from the UK illustrates how the principles discussed in the handbook have been put into practice.

Alistair Gray examines how the team at East Lancashire Hospitals, UK, has adopted a holistic approach to fluid management and stewardship, which encompasses aspects such as storage, the range and volume of stockholding in wards, education and auditing. He outlines the practical steps taken, the challenges faced and the solutions implemented, along with the additional actions being pursued as audits reveal how effectively practice aligns with policy.

In conclusion, our handbook demonstrates that fluid stewardship is a transformative approach that elevates fluid therapy from routine practice to a cornerstone of high-quality, evidence-based care. We hope you find the content informative and educational and will help lay the groundwork to enhance your clinical practice.

Thank you for reading!

Addressing the fundamentals of fluid therapy

Fluid management is vital in specific inpatient medical environments, where each patient has distinct and individual needs. Although there is no universal, one-size-fits-all solution, replenishing lost fluids when a deficit is identified is a fundamental principle applicable to all patients, as Professor Robert Hahn explains

Robert Hahn MD PhD
Karolinska Institutet, Stockholm, Sweden

Patients frequently endure conditions that hinder their capacity to regulate hydration status, and inadequate fluid management – whether depletion or overload – can result in considerable morbidity and mortality. Consequently, it is vital to meticulously assess the specific type and quantity of fluids required in each individual case.

Types of fluids

Crystalloids

Crystalloids are aqueous solutions that contain mineral salts and other small, water-soluble molecules. Most commercially available crystalloid solutions are isotonic, or nearly isotonic, with human plasma.

Commonly used fluids are:

- Sodium chloride (0.9%) or normal saline, with or without potassium
- Sodium chloride (0.45%) or half normal saline, with or without potassium
- Lactated Ringer solution
- Dextrose (glucose) (5%) in sodium chloride (0.9%), with or without potassium
- Dextrose (glucose) (5%) in sodium chloride (0.45%), with or without potassium.[1]

Lactated Ringer solution closely resembles the concentrations of various solutes present in plasma and do not exert an osmotic effect *in vivo*. This fluid increases intravascular volume without altering ion concentrations or causing significant fluid shifts between the intracellular and extracellular spaces. Normal saline behaves in a similar way in the body but has an unphysiological electrolyte composition. The fluids containing 0.45% saline have a partial intracellular distribution. Glucose solutions prevent starvation and initially attract fluid to the extracellular space (30–60 min) when combined with electrolytes.

Buffered solutions consist of molecules that metabolise *in vivo* into bicarbonate. These solutions are formulated to sustain a normal physiological pH of plasma. The three most commonly used buffer molecules are lactate, acetate, and gluconate.

Colloids

Colloids include albumin (5% and 20%), hydroxyethyl starch, and gelatin. Each contains a macromolecule that passes through the capillary membrane only with difficulty, meaning that the plasma expansion effects last longer than those of crystalloids.

The composition is such that the fluid expands the plasma volume by almost the same volume as was infused.[3] An exception is albumin 20%, which recruits extravascular fluid and thereby expands the plasma volume by twice the infused volume.

Colloid fluids are more expensive crystalloids and may cause mild allergic reactions (1 in 500).[4] They also induce slight impairment of the coagulation system, particularly in larger volumes (>1 L). Restrictions have been imposed on the use of hydroxyethyl starch due to an increased incidence of kidney injury in patients with sepsis,[5] although such issues have not been observed in surgical patients.[6,7]

Colloid fluids are second-line treatments of hypovolaemia but are most useful when the amount of infused crystalloid fluid is so large that the risk of adverse effects is an issue.[8]

Indications for fluid prescribing

Oral administration is the most natural and preferred method of receiving fluids. However, many patients may be unable to tolerate oral intake due to acute or severe illness. In such cases, alternative routes, such as enteral or intravenous (IV) access, offer a direct means of delivering fluids to the vascular system. Healthcare professionals should be aware of the reasons for administering fluids and should continuously reassess the necessity of continuing them.

When prescribing IV fluids, the following '5 Rs' should be taken into account:

- Routine maintenance
- Replacement
- Resuscitation
- Redistribution
- Reassessment.[9]

Routine maintenance

Routine maintenance is necessary when a patient is unable to take in fluids through eating or drinking. The fluid used for routine maintenance is a solution comprising glucose (dextrose), typically at a concentration of 5%, along with 40 mmol sodium and 20–40 mmol potassium. The recommended amount is 25–30 mL/kg/day, which compensates for normal evaporation and urine output.[9]

The glucose content is low but still limits starvation-induced muscle breakdown. One litre of 5% glucose provides only 200 kcal. The fluid should be administered slowly (over four to six hours) because the body is inefficient at utilising intravenous glucose as the gastrointestinal hormonal system is bypassed.[10] Moreover, sick patients and those undergoing surgery develop insulin resistance, meaning that insulin has a poorer effect than usual.[11,12]

It is advised to monitor blood glucose levels due to the risk of hyperglycaemia when 5% glucose is administered IV.[13]

Transient elevations up to 10 mmol/L can be tolerated,[14] but higher concentrations promote infection. Levels of 13–15 mmol/L result in osmotic diuresis, causing the kidneys to lose control over the excretion of glucose, electrolytes, amino acids and water. These are potentially serious iatrogenic adverse effects and should be prevented by maintaining good control over the infusion rate, preferably by using an infusion pump.

Sodium and potassium in glucose 5% solutions are needed as the kidneys continuously excrete these electrolytes. A rule is to provide 1–2 mmol/kg sodium and 1 mmol/kg potassium per day.[15] Electrolyte-free glucose solution ('plain' glucose) may be provided if the plasma electrolytes are high, but more than 1 L should not be given due to the risk of hyponatraemia.

Glucose 5% with electrolytes initially distributes throughout the extracellular space but gradually hydrates the intracellular space as fluid accompanies the cells' insulin-dependent glucose uptake.[10] In fact, glucose solutions are the only IV fluids that hydrate the intracellular space, which is necessary since most evaporative water losses originate from this body fluid compartment.

After an infusion of glucose 5% is started, two-thirds of the steady-state concentration (i.e., two half-lives) can be measured 30 min later in a healthy person. During surgery the two-thirds is reached later, at 50–60 min.

Glucose 2.5% is intended for use when more fluid volume is needed, such as postoperatively. Higher concentrations (10% and 20%) are marketed but need to be matched with insulin administration whereby blood glucose monitoring becomes imperative. Infusion in a peripheral vein might be painful as these fluids are strongly hypertonic.

Maintenance therapy involving only 5% glucose with electrolytes may be continued for up to one week. After that, a transition to full parenteral nutrition should be considered.

Replacement therapy

Losses of body fluid may cause decreases in blood volume (hypovolaemia), extracellular volume (volume depletion), or both extracellular and intracellular fluids (dehydration). The appropriate fluid to replace the loss depends on the type of fluid lost.

For example, an elderly person who has not ingested food and has consumed only minimal water for days should be compensated with maintenance fluid at a higher rate than usual and then monitored by blood glucose measurements. In this setting, glucose 2.5% with electrolytes allows faster rehydration than glucose 5%. If the arterial pressure is low, resuscitation fluid can be added.

Vomiting is a common reason for replacement therapy. The recommended fluid is isotonic saline because this fluid contains a surplus of chloride (154 mmol/L vs 100 mmol/L in plasma) which compensates for the loss of chlorides and the acidic composition of the gastric juice.[9,16]

Fluid losses from diarrhoea, ileus and drains have a variable composition of electrolytes, necessitating individualised treatment.[17] Fluid losses from the upper gastrointestinal tract may contain significant amounts of bicarbonate, leading to acidosis.

Resuscitation

Resuscitation fluids expand the extracellular space, of which plasma volume constitutes one-fifth. They are indicated in cases of volume depletion and hypovolaemia and, importantly, serve as a means of supporting circulation in severe disease and during surgery.[18,19] These situations involve disease-related or drug-induced impairment of the adrenergic system, which redirects blood flow and increases intravascular space, thereby

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causing haemodynamic depression (in terms of arterial pressure and cardiac output). The aim of fluid treatment is to increase blood volume above its normal range. The appropriate increase is best determined by what the heart can pump, which can be assessed by its response to a short bolus infusion.

The most widely used resuscitation fluid is Ringer's lactate, which has an electrolyte composition similar to that of extracellular fluid but contains no glucose. Plasma-Lyte is an alternative solution whose composition aligns slightly better with the chemistry of extracellular fluid. Isotonic saline is also employed, but it deviates in several aspects from the optimal composition. Several large studies do not support the notion that isotonic saline worsens the outcomes of surgery or intensive care treatment; however, it is still best reserved for patients with metabolic alkalosis (such as after vomiting) or hyponatremia.[17]

Crystalloid fluids given intravenously have a good initial plasma volume expanding capacity, with 45–50% remaining in the blood at the end of a 30-min infusion. The capacity decreases rapidly over a 30-min post-infusion distribution period due to volume equilibration across the extracellular space. The final plasma volume expansion is 15–20% of the infused volume, but the precise fraction is dependent on the associated urine output.[3]

There is no rule about how fast these fluids can be infused, as with glucose solutions, but the cardiovascular system must be able to handle the load. Patients with heart failure who have a poor ability to increase cardiac pumping must be given crystalloid fluid judiciously and under tight control. Too fast an infusion can cause pulmonary oedema.

Redistribution

Fluid prescriptions should be adjusted to account for any fluid or electrolyte deficits or excesses and any complex issues or comorbidities (e.g., severe sepsis, gross oedema, renal or cardiac impairment) should be referred for expert management.[9]

Reassessment

Patients receiving IV fluids should be monitored and reassessed regularly. The ABCDE (Airway, Breathing, Circulation, Disability and Exposure) criteria, which involve monitoring respiratory and pulse rates, blood pressure, venous lactate levels, and arterial pH, should be employed.[9]

The ROSE concept in severe illness

Four treatment phases recognise the necessity for transient expansion of the extravascular volume during severe

illness: resuscitation, optimisation, stabilisation and evacuation (ROSE).[20,21]

Resuscitation

Patients who arrive in the intensive care unit may initially require significant amounts of resuscitation fluid to address shock. The volume loading aims to enhance circulation sufficiently to ensure adequate delivery of blood to the tissues.

Optimisation

After a few hours, careful fluid titration can often be performed alongside the administration of a vasoactive drug.

Stabilisation

The patient typically undergoes a period lasting a few days when haemodynamics are stable, and mostly maintenance fluid is needed; treatment efforts can then shift towards addressing the cause of the illness and any associated complications.

Evacuation

As the severe illness improves, the need for volume overload to stabilise circulation diminishes, potentially leading to fluid-related complications. Consequently, the fourth phase focuses on removing excess fluid. This is achieved by reducing fluid administration and, in the haemodynamically stable patient, by administering carefully measured amounts of diuretics.

De-resuscitation requires patience, as it cannot be accomplished swiftly. A markedly negative fluid balance may be linked with hypovolaemia and hypotension, which can hinder recovery. A duration of two to three days for this phase is typical.

Paediatrics: a special population

Physiological changes during growth prompt various adaptations of the fluid therapy in the paediatric population. Children's daily fluid needs strongly depend on body weight and are often calculated according to the 4-2-1 rule.[22,23] Prolonged fasting before surgery should be avoided and early return to oral ingestion after surgery is more important than in adults. The electrolyte composition of the infusion fluids can be the same as in adults, but children are more prone than adults to develop hypoglycaemia and hyponatraemia. Therefore, special resuscitation fluids are marketed for perioperative use in children that contain a small amount of glucose (1%) and a slightly higher sodium concentration than in Ringer solution.[24]

Adverse effects

Infusion of fluid has a cooling effect on the body and large volumes may cause shivering. A temperature drop to < 35oC increases blood loss due to coagulopathy.[25] Warming the fluid during major surgery is good practice.

All infusion fluids impair coagulation through dilution, which necessitates implementing maximum doses for colloids due to their strong dilution effect. A critical point occurs when the plasma fibrinogen concentration falls below 1 g/L (the normal range is 1.5–3.0 g/L).[27] Some studies of colloid fluids demonstrate specific effects on coagulation beyond the dilution effect.

Adverse effects of glucose solutions consist of hyperglycaemia in response to fast infusion and hyponatraemia when 'plain glucose' is given repeatedly.

Crystalloid fluids may cause acute pulmonary oedema if infused more rapidly than the heart's capacity to manage the volume. In a healthy adult, 2 L over 30 minutes presents no issues. A cumulative dose of 3 L during surgery can lead to gastrointestinal paralysis lasting a few days. Larger volumes increase the risk of suture breaks, particularly in the gastrointestinal tract, as well as the risks of postoperative pulmonary infection and pulmonary oedema.[26,27] Animal studies indicate that even larger volumes can cause structural tissue damage that disrupts organ function.

Isotonic saline causes metabolic acidosis that becomes apparent when 2 L has been infused.[28] Saline also inhibits kidney function and is excreted only two-thirds as fast as Ringer's.[29]

Isotonic saline does not contain calcium, which means that it does not cause coagulation in the intravenous line if infused together with citrate-anticoagulated blood. By contrast, Ringer solutions contain calcium and may have this adverse effect.

Colloid fluids may lead to allergic reactions, a concern not associated with crystalloid fluids.[4]

Education and training

Hospitals should establish systems to ensure that all healthcare professionals involved in prescribing and administering IV fluid therapy are adequately trained.[9] Formal assessment and regular reassessment are crucial for maintaining competency. It is suggested to establish a lead for IV fluids, responsible for training, auditing, and reviewing all IV fluid prescribing practices and patient outcomes.[9]

Prescribing key learning points

- Infusion fluids are sterile aqueous solutions with an osmolality similar to plasma (295 mmol/kg). A lower osmolality may lead to haemolysis, which is the excessive swelling of erythrocytes, which can harm the kidneys
- Including electrolytes guarantees the correct osmolality, except for 'plain' glucose, which is iso-osmotic due to its glucose content
- The prescriber is responsible for ensuring an appropriate infusion rate of fluids containing glucose. If additional potassium is prescribed, the administration rate must not exceed 10 mmol/h due to potential adverse effects on cardiac rhythm
- Crystalloid electrolyte fluids may be administered at a rate that the patient's cardiovascular system can tolerate. This rate varies among individuals but is typically higher than the appropriate infusion rate for glucose solutions
- Drugs are frequently dissolved in infusion fluid for administration in the intensive care unit. The volume of fluid used is typically low (100–250 mL) but may increase significantly if multiple drugs are given.[30] Be mindful of the recommended fluid to use with each drug and ensure that it is readily dissolved before administration.
- The rational use of infusion fluids requires that the prescriber remain aware of and continually reevaluate the requirement for administering fluids via intravenous infusion. If feasible, providing fluids and nutrition through oral intake is a preferable alternative.
- The prescriber must also be mindful of the fluid's composition and whether the therapy is intended for maintenance, replacement, or resuscitation. While it is indeed possible to treat a patient along two therapeutic avenues, these should be distinctly differentiated.
- And above all remember: Every time you prepare a fluid bag for administration intravenously, you should know what the fluid is used for and what it contains. Be aware of the benefits and risks of providing the specific fluid, just as you would when administering drugs.

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References

1 Castera M, Borhade M. Fluid management. StatPearls [Internet] 2023.
2 Epstein A, Patel P, Waseem M. Crystalloid fluids. StatPearls [Internet] 2024.
3 Hahn RG. Understanding volume kinetics. Acta Anaesthesiol Scand 2020;64:570–8.
4 Laxenaire MC, Charpentier C, Feldman L. Anaphylactoid reactions to colloid plasma substitutes: incidence risk factor mechanisms. A French multicenter prospective study. Ann Fr Anesth Reanimat 1994;13:301–10.
5 Reinhart K et al; European Society of Intensive Care Medicine. Consensus statement of the ESICM task force on colloid volume therapy in critically ill patients. Intensive Care Med 2012;38:368–83.
6 Iyer KV et al. Association between intraoperative starch use and postoperative kidney dysfunction in patients undergoing major gastro-intestinal surgery: A propensity score-matched analysis. J Perioper Pract 2025;35:14–21.
7 Yang MJ et al. Association between hydroxyethyl starch 130/0.4 administration during noncardiac surgery and postoperative acute kidney injury: A propensity score-matched analysis of a large cohort in China. J Clin Anesth 2024;96:111493.
8 Joosten A et al. Crystalloid versus colloid for intraoperative goal-directed fluid therapy using a closed-loop system: a randomized, double-blinded, controlled trial in major abdominal surgery. Anesthesiology 2018;128:55–66.
9 National Institute for Health and Care Excellence (NICE). Intravenous fluid therapy in adults in hospital. www.nice.org.uk/guidance/cg174 (accessed February 2025).
10 Sjöstrand F, Edsberg L, Hahn RG. Volume kinetics of glucose solutions given by intravenous infusion. Br J Anaesth 2001;87:834–43.
11 Thorell A, Nygren J, Ljungqvist O. Insulin resistance: a marker of surgical stress. Curr Opin Clin Nutr Metab Care 1999;2:69–78.
12 Ljunggren S, Hahn RG, Nyström T. Insulin sensitivity and beta-cell function after carbohydrate oral loading in hip replacement surgery. Clin Nutr 2014;33:392–8.
13 Hahn RG. How fast can glucose be infused in the perioperative setting? Perioper Med (Lond) 2016;5:1.
14 Sreedharan R, Khanna S, Shaw A. Perioperative glycemic management in adults presenting for elective cardiac and non-cardiac surgery. Perioper Med (Lond) 2023;12:13.
15 Hahn RG, Van Regenmortel N. Is the NICE Guideline for Maintenance Fluid Therapy in Adults in Hospital appropriate? Clin Nutr ESPEN 2024;63:113–20.
16 Malbrain MLNG et al. Multidisciplinary expert panel report on stewardship: perspectives and practice. Ann Intensive Care 2023;13:89.
17 Vather R, Bissett I. Management of prolonged post-operative ileus: evidence-based recommendations. ANZ J Surg. 2013; 83: 319-24.
18 Malbrain MLNG et al. Intravenous fluid therapy in the perioperative and critical care setting: Executive summary of the International Fluid Academy (IFA). Ann Intensive Care 2020;10:64.
19 Arabi YM et al. European Society of Intensive Care Medicine. European Society of Intensive Care Medicine clinical practice guideline on fluid therapy in adult critically ill patients. Part 1: the choice of resuscitation fluids. Intensive Care Med 2024;50:813–31.
20 Malbrain MLNG, Van Regenmortel N, Owczuk R. It is time to consider the four D's of fluid management. Anaesthesiol Intensive Ther 2015;47:s 1–5.
21 Malbrain MLNG et al. Principles of fluid management and stewardship in septic shock: it is time to consider the four D's and the four phases of fluid therapy. Ann Intensive Care 2018 May 22;8(1):66.
22 Mathew A, Rai E. Pediatric perioperative fluid management. Saudi J Anaesth 2021;15:435–40.
23 National Institute for Health and Care Excellence (NICE). Intravenous fluid therapy in children and young people in hospital. NG29. www.nice.org.uk/guidance/ng29 (accessed February 2025).
24 Sümpelmann R et al; German Scientific Working Group for Paediatric Anaesthesia. European consensus statement for intraoperative fluid therapy in children. Eur J Anaesthesiol 2011;28:637–9.
25 Morrison RC. Hypothermia in the elderly. International Anesthesiology Clinics 1988;26:124–33.
26 Hahn RG. Adverse effects of infusion fluids. In: Hahn RG (ed) Clinical Fluid Therapy in the Perioperative Setting. 2nd Ed. Cambridge University Press, Cambridge 2016:262–9.
27 Arieff AI. Fatal postoperative pulmonary edema. Pathogenesis and literature review. Chest 1999;115:1371–7.
28 Scheingraber S et al. Rapid saline infusion produces hyperchloremic acidocis in patients undergoing gynecologic surgery. Anesthesiology 1999;90:1265–70.
29 Hahn RG. Influences of the red blood cell count on the distribution and elimination of crystalloid fluid. Medicina 2017;53:233–41.
30 Van Regenmortel N et al. Maintenance fluid therapy and fluid creep impose more significant fluid, sodium, and chloride burdens than resuscitation fluids in critically ill patients: a retrospective study in a tertiary mixed ICU population. Intensive Care Med 2018;44:409–17.

Defining fluid stewardship: a hospital pharmacy perspective

Despite the recognised importance of fluid management, inappropriate fluid use remains a significant care deficit in many organisations. Here, Stephanie Wuyts and Pieter Cornu outline the core principles of fluid stewardship, identify the key stakeholders involved in implementing successful programmes, and explain how these initiatives benefit both hospitals and society by enhancing patient outcomes and reducing fluid-related costs

Stephanie Wuyts MSc PhD candidate
Pharmacy Department, Universitair Ziekenhuis Brussel (UZ Brussel); Research Centre for Digital Medicine, Vrije Universiteit Brussel (VUB), Belgium

Pieter Cornu MSc PhD
Research Centre for Digital Medicine, Vrije Universiteit Brussel (VUB); Department of Information and Communication Technology, Universitair Ziekenhuis Brussel (UZ Brussel), Belgium

Multifaceted strategies targeting all aspects of the medication process prone to errors, starting with the prescription, pharmacist review, nurse preparation of the fluid bag, and then administration and monitoring, are preferred for all parenteral drugs, including intravenous (IV) fluids, to guarantee the 'nine rights of medication'.[1]

As such, the overall goal is to administer the 'right fluid' to the 'right patient' in the 'right dose', at the 'right time' via the 'right route' for the 'right reason'. Next, ensuring a 'right response', providing 'right patient education' and 'right documentation' in the patient file encompasses all safety concerns.[1]

Fluid stewardship: why is it important?

Fluid stewardship is a coordinated approach to optimise fluid therapy by choosing the appropriate fluid, dosage, and duration, while minimising adverse effects and costs.[2]

Over the years, stewardship programmes targeting specific drug classes have become increasingly important in hospitals to ensure judicious and prudent use. For example, antibiotics and antifungal drugs are often used inappropriately, enhancing the risk of patient harm and increased costs caused by antimicrobial resistance. Different societies have developed written guidelines for implementing institutional programmes focusing on these drug classes. Multifaceted quality improvement strategies such as stewardship programmes are therefore advocated to guard patient safety.[3,4]
Besides antimicrobial drugs, other drugs are also targeted with this type of intervention (e.g., anticoagulants and opioids).[5,6]

What are the aims of fluid stewardship?

Usually, fluid stewardship programmes are focused on critical care services and perioperative use, but the careful management of these drugs is also essential on general medical wards.[7,8]

As healthcare professionals often possess suboptimal knowledge regarding IV fluids,[9–11] and given the frequent irrational use of these fluids,[12,13] there is a potential risk for iatrogenic complications related to the administration of fluids and electrolytes. Consequently, these substances are frequently subject to stewardship interventions.

When stewardship principles are applied for rationalising IV fluid therapy, the primary aim is to prescribe the most appropriate drug, which means a fluid individualised to the patient's clinical needs.

Secondary aims include preventing drug-related adverse events and exploring areas for cost containment.[13] Centralised governance of fluid stewardship programs is essential. At the hospital level, this position can be fulfilled by, for example, the Drug and Therapeutics Committee (DTC) engaging in its role as a multidisciplinary task force responsible for ensuring rational pharmacotherapy throughout the organisation.[14–16] Thus, well-managed fluid stewardship can improve patient safety, efficient use of resources, and institutional sustainability.

Defining the principles of stewardship

The principles of stewardship were defined by the World Health Organization (WHO) in the 'World Health Report 2000'. This report summarised stewardship as, 'the careful and responsible management of the well-being of the population'.[17]

For this purpose, governmental responsibilities should be embedded throughout all layers of the healthcare system, progressing down to local institutions.

The core elements

Three core elements of stewardship have been identified by WHO:
1 Sharing a collective vision
2 Influencing behaviour to achieve better outcomes by design of a defined outcome set and implementation of compliance checks
3 Acquiring actionable intelligence to further improve the quality of healthcare.[17]

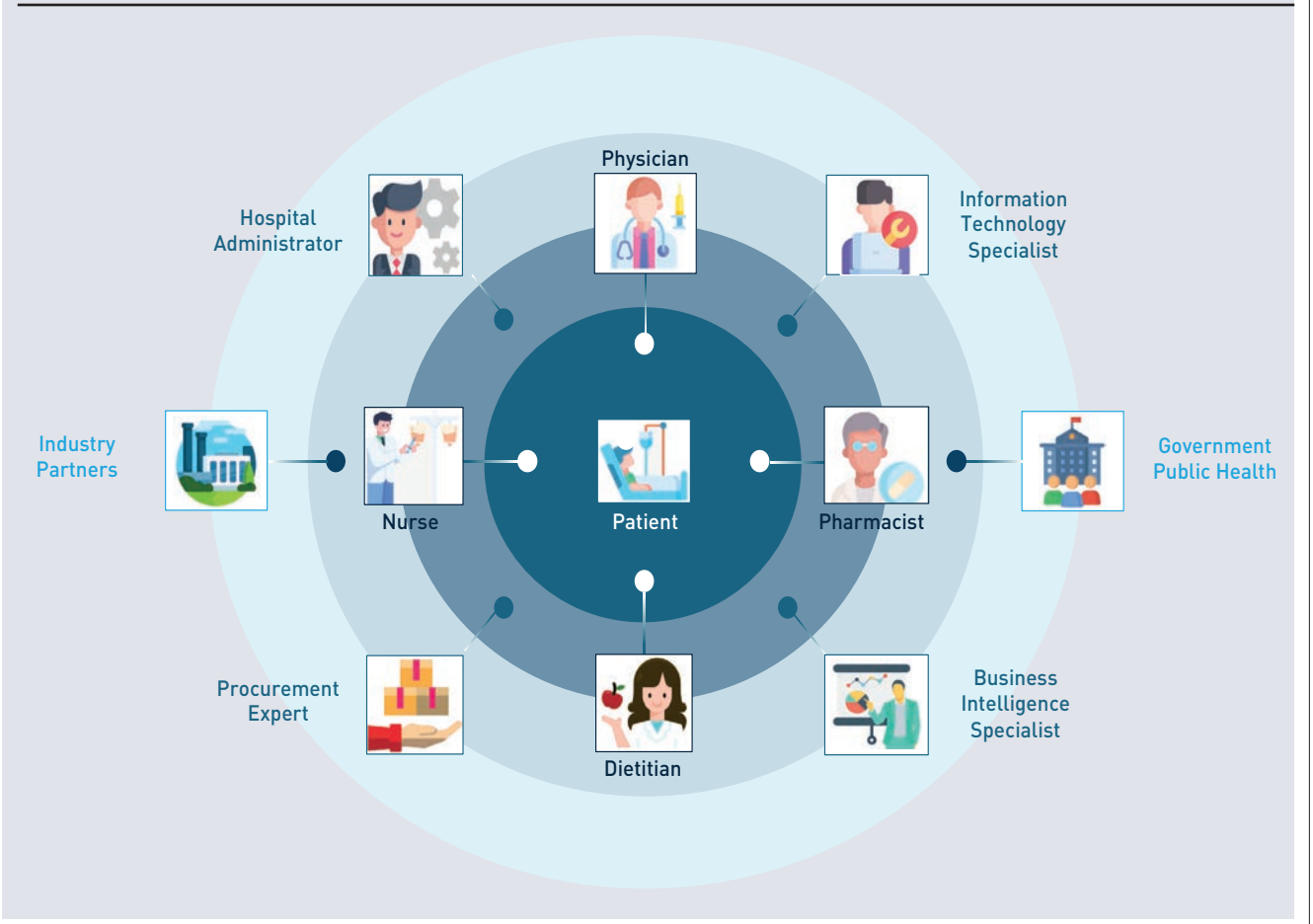
Intrinsically, effective stewardship is only possible when the generation of intelligence leads to policy formulation, which then requires tools, partnerships, organisational alignment, and accountability mechanisms.[18] As such, a stewardship programme is an excellent medium to improve rational pharmacotherapy (i.e., provision of drugs to patients with a clinically meaningful indication, in individualised doses, for an optimal duration) and optimise financial resources for both the patient and their environment, in organisations on all levels.[19]

Fluid stewardship in the hospital: key stakeholders

The involvement of multiple stakeholders is therefore essential, alongside a systematic approach to implement fluid stewardship.

FIGURE 1

Fluid stewardship stakeholders



Fluid stewardship requires the coordinated efforts of multiple stakeholders, all focusing on the patient's benefit. The relationship between all stakeholders is visualised in Figure 1.

Internal partners

In the inner circle, the patient is identified as the one potentially exposed to fluid-related harm. A care team, most frequently consisting of a physician, nurse, pharmacist and including support from a dietitian, is mainly responsible for daily fluid management.

Physicians make clinical decisions regarding the indication for fluid administration (e.g., resuscitation, maintenance or replacement) based on the patient's clinical needs and stewardship principles. They assess the patient's fluid balance, laboratory results and weight in order to prescribe the most appropriate IV fluid, if required.[20]

Consequently, nurses are on the ward for fluid administration, monitoring of patient responses (e.g., blood pressure, heart rate, urine output) and providing critical feedback to the medical team.[21] A clinical pharmacist on the ward offers additional expertise on fluid management alongside support in monitoring therapy.[22–24]

Dietitians are typically involved only in nutritional management. However, as fluids are administered both enterally and parenterally, their expertise is also valuable in monitoring overall fluid therapy in hospitalised patients.[25]

All of these healthcare professionals are also actively involved in the hospital's fluid policy and governance of fluid stewardship, with support from experts in hospital administration, IT, business intelligence, and procurement. Backing from the board of directors is essential for policy development, resource allocation and, ultimately, the implementation of fluid stewardship programmes.

IT specialists are crucial for data collection and the further development of electronic clinical decision support systems for fluid therapy. Business intelligence officers can perform data analysis and create dashboards to support the clinical expert team. Given that drug shortages present a daily challenge, the role of procurement experts in fluid stewardship is essential; they negotiate with suppliers for high-quality products at competitive prices and assist with supply chain management. Additionally, including clinical researchers in the team could enhance evidence-based practices by studying the effectiveness of the implemented stewardship interventions.

External partners

External partners are pictured in the outer circle of Figure 1.

Industry partnerships are strongly recommended for the development of high-quality products, collaboration in compliance with regulatory guidelines, on-site training and education, implementing track-and-trace solutions for fluids within hospitals, ensuring secure and reliable fluid supplies, and exploring green waste management strategies (e.g., biodegradable packaging and sustainable disposal methods). A secondary partnership with public health governance

TABLE 1

A toolbox for fluid stewardship

Availability of actionable knowledge	Gain insight into current clinical practices: a recent inventory of fluid usage, understanding of current knowledge of healthcare professionals involved in fluid management and a baseline measurement of relevant outcomes associated with IV fluid administration
Hospital-wide policies on IV fluid prescribing, storage and administration	Several international organisations, such as the National Institute for Health and Care Excellence (NICE) and the Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients (GIFTASUP) have summarised strategic recommendations for IV fluid management in practical algorithms, aims and objectives.[20,21] These objectives can be translated to the hospital's own setting. They are preferably defined in a 'SMART' manner, i.e., Specific, Measurable, Achievable, Relevant and Timely
Influencing healthcare professionals' behaviour	Educational activities, training and providing audit and feedback are key.[18] Continuing and repeating education on IV fluids is necessary for all involved healthcare professionals and comprise the fluid prescription, administration, patient monitoring and recommendations for the documentation of a management strategy in the electronic health record.[2] Depending on the availability of new evidence, the educational material should be updated regularly and re-disseminated
Interdepartmental collaboration	Teamwork among core personnel is crucial to streamline fluid management. Professionals from other clinical specialties such as vascular access (e.g., anaesthesiologists and specialist care nurses), infectious diseases and nutrition can contribute valuable expertise to warrant the programme's safety[26]
Finding the fit between achieving the IV fluid policy objectives and the hospital's structure and culture	One approach in stewardship is to train and appoint 'champions' or 'stewards' to act as direct liaisons between the DTC and local care teams. These dedicated persons can thus support daily practice with their knowledge and gain insights into barriers and facilitators for the successful implementation of fluid guidelines. Other complementary approaches are the incorporation of fluid policy into existing workflows and hospital information systems. For example, the combination of computerised physician order entry with automated, rule-based or artificial intelligence driven, clinical decision support systems facilitates flagging of inappropriate fluid prescriptions, laboratory parameters or other clinical parameters to identify patients at risk for inappropriate fluid therapy.[27] Additionally, pharmacist-led fluid prescription review and adjustment, preferably before administration, may further decrease the risk for medication errors or harm[22,23]
Accountability, assessment and audit	Ensuring full accountability is the next phase following implementation, but also remains important during the continuation of the fluid stewardship programme[18] Combine key performance indicators based on the programme's objectives, active pharmacovigilance[15,28] and clinical audit to identify areas of improvement in either the healthcare professional's knowledge base or in their workflow to obtain a comprehensive assessment of the effect of the fluid stewardship programme on all stakeholders

boards within health agencies can be vital for preventing supply chain disruptions during crises and for expanding fluid stewardship to a national level.

A toolbox for fluid stewardship

Several essential elements ought to be included in a toolbox of every healthcare professional engaged in fluid stewardship within the hospital (see Table 1). Some aspects of this are discussed further later in this handbook.

Achieving long-term adherence

Implementing fluid stewardship is a potentially straightforward step; however, achieving sustained adherence to the hospital fluid policy can be challenging. Therefore, it is crucial to maintain an open mind in quality improvement programmes and to evaluate each adaptation to the programme in a structured manner.

The Plan-Do-Study-Act cycle is an iterative process defined by the Institute of Health Improvement that is applicable to any action-oriented learning process. This process emphasises the need to initially test every change on a limited scale. It includes a plan, observations and analysis of the outcomes, and then actions to further modify the results if any deviations are noticed.[29]

Conclusion

Complications arising from inappropriate IV fluid administration can adversely affect patient outcomes and

escalate hospital costs. Establishing a fluid stewardship programme can serve as a crucial facilitator to improve rational IV fluid therapy.

Although this is a relatively recent concept, the principles for effective stewardship programmes have been defined by the WHO since the early 2000s. Therefore, identifying the essential elements and central stakeholders for implementing fluid stewardship in the hospital is the first step to improving the quality of fluid-related care. Alongside other experts involved, hospital pharmacists have a vital role to play in implementing and monitoring the programme's effectiveness and, thus, its ultimate success.

References

1 Elliott M, Liu Y. The nine rights of medication administration: an overview. Br J Nurs 2010;19(5):300–5.
2 Malbrain M et al. Multidisciplinary expert panel report on fluid stewardship: perspectives and practice. Ann Intensive Care 2023;13(1):89.
3 Drew RH et al. Insights from the Society of Infectious Diseases Pharmacists on antimicrobial stewardship guidelines from the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America. Pharmacotherapy 2009;29(5):593–607.
4 Policy statement on antimicrobial stewardship by the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), and the Pediatric Infectious Diseases Society (PIDS). Infect Control Hosp Epidemiol 2012;33(4):322–7. doi:10.1086/665010
5 Porres-Aguilar M et al. Impact of Hospital-based Multidisciplinary Anticoagulation Stewardship Programs. Arch Med Res 2023;54:1–6.
6 Shoemaker-Hunt SJ, Wyant BE. The Effect of Opioid Stewardship Interventions on Key Outcomes: A Systematic Review. J Patient Saf 2020;16(Suppl 1):S36–S41.
7 Leach R. Fluid management on hospital medical wards. Clin Med (Lond) 2010;10(6):611–15.
8 Malbrain M et al. Principles of fluid management and stewardship in septic shock: it is time to consider the four D's and the four phases of fluid therapy. Ann Intensive Care.2018;8(1):66.
9 McCrory RFR et al. Learning to prescribe intravenous fluids: A scoping review. Perspect Med Educ 2017;6(6):369–79.
10 Wuyts SCM et al. Interdisciplinary knowledge gaps on intravenous fluid management in adult patients: Survey among physicians and nurses of a university hospital. J Eval Clin Pract 2022;28(4):599–606.
11 Nasa P et al. Intravenous fluid therapy in perioperative and critical care setting-Knowledge test and practice: An international cross-sectional survey. J Crit Care 2022;71:154122.
12 Gao X et al. Inappropriate prescribing of intravenous fluid in adult inpatients-a literature review of current practice and research. J Clin Pharm Ther 2015;40(5):489–95.
13 Malbrain M et al. It is time for improved fluid stewardship. ICU Management Practice 2018;18:158–62.
14 Durán-García E et al. Literature review on the structure and operation of Pharmacy and Therapeutics Committees. Int J Clin Pharm 2011;33(3):475–83.
15 World Health Organization. Drug and therapeutics committees: a practical guide. Geneva: World Health Organization;2003.
16 Ciccarello C et al. ASHP Guidelines on the Pharmacy and Therapeutics Committee and the Formulary System. Am J Health Syst Pharm 2021;78(10):907–18.
17 World Health Assembly. The World Health Report 2000: health systems: improving performance. Geneva: World Health Organization;2000.
18 Travis PE, Davies D, Mechbal P. A. Towards better stewardship: concepts and critical issues. Geneva: World Health Organization;2002:9.
19 World Health Organization. The Rational Use of Drugs: Review of Major Issues. In: Conference of Experts on the Rational Use of Drugs and World Health Organization. Geneva: World Health Organization;1985:9.
20 Padhi S et al. National Institute for Health and Clinical Excellence guideline development group (2013) Intravenous Fluid Therapy in Adults in Hospital. BMJ 2013;347:f7073.
21 Powell-Tuck JG et al. British Consensus Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients 2011:50. www.bapen.org.uk/pdfs/bapen_pubs/giftasup.pdf (accessed February 2025).
22 Bülow C et al. Medication review in hospitalised patients to reduce morbidity and mortality. Cochrane Database Syst Rev 2023;1(1):CD008986.
23 Smith SE et al. Relationship between medication regimen complexity and pharmacist engagement in fluid stewardship. Am J Health Syst Pharm 2024;Dec 6:zxae369.
24 The European Statements of Hospital Pharmacy. EJHP 2014;21(5):256–8.
25 Leach RM et al. Nutrition and fluid balance must be taken seriously. BMJ 2013;346:f801.
26 Timsit JF et al. A state of the art review on optimal practices to prevent, recognize, and manage complications associated with intravascular devices in the critically ill. Intensive Care Med 2018;44(6):742–59.
27 Kane-Gill SL et al. Clinical decision support for drug related events: Moving towards better prevention. World J Crit Care Med 2016;5(4):204–11.
28 Raber JH. The formulary process from a risk management perspective. Pharmacotherapy 2010;30(6 Pt 2):42s–7s.
29 Taylor MJ et al. Systematic review of the application of the plan-do-study-act method to improve quality in healthcare. BMJ Qual Saf 2014;23(4):290–8.

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Fluid prescribing and stewardship: strategies to achieve best practice

Recognising intravenous fluids as medications with specific indications and contraindications is vital for safe and effective fluid management. Inappropriate use of fluids can lead to electrolyte disturbances and serious complications. In this article, Professor Manu Malbrain presents an evidence-based framework and best practice strategies to support systematic and judicious fluid prescribing

Manu Malbrain MD PhD
First Department of Anaesthesia and Intensive Therapy, Medical University of Lublin, Lublin, Poland; International Fluid Academy, Lovenjoel, Belgium; and Medical Data Management, Medaman, Geel, Belgium

Fluid stewardship is a systematic approach to optimising fluid therapy. It involves selecting the appropriate fluid, dose, and duration while minimising adverse effects and costs.

In time-critical emergency care

Resuscitation using intravenous (IV) fluid prescriptions is especially common in emergency and critical care as well as in cases of severe illness.

In sepsis, for instance, the 'golden hour' refers to either a one-hour interval from the door to antibiotics or from the door to IV fluids.[1,2] Fluids can be life-saving for the kidneys and other organs; however, they may also lead to mixed consequences.[3]

A typical postoperative patient with abdominal sepsis may receive a saline infusion for low blood pressure, reduced urine output, low central venous pressure, or fluid responsiveness. As a result, the patient could ultimately receive five bags of saline. This often leads to a positive sodium and fluid balance, as saline boluses are routinely administered for various issues in the intensive care unit.

Over time, this can lead to acute kidney injury (AKI), abdominal distension, increased intra-abdominal pressure, and further deterioration of kidney function, potentially resulting in abdominal compartment syndrome. These scenarios underscore the critical importance of preventing fluid accumulation syndrome through effective fluid stewardship.

Appropriate fluid management: addressing misconceptions

Fluid status is crucial; however, many myths persist, such as the assumption that all septic patients are hypovolaemic (they may simply be vasoplegic) or that fluid responsiveness necessarily justifies fluid administration.

As detailed earlier in the handbook, there are four primary indications for administering fluids: resuscitation (to save lives), routine maintenance (to cover the daily needs of water, sodium and glucose), replacement (to mimic the lost fluids, such as administering saline for gastrointestinal losses), and re-energising or nutritional fluids (to meet the daily calorie needs if the gut cannot be used).[4,5]

A fifth indication could be to dissolve or dilute other drugs (such as antibiotics, analgesics, sedatives, etc). These fluids are termed creep fluids, and they seep into the patient without the intention of administering fluids. It should be remembered that all IV fluids will eventually be lost to the interstitial space. It is only a matter of time before they redistribute and may contribute to fluid creep and lead to unintentional over-hydration.

Most large fluid trials focus on resuscitation fluids, leaving maintenance solutions less well-studied.[6,7] Research has shown that a significant portion of administered fluids – approximately 33% – can be attributed to unintentional fluid creep, highlighting the need for proper documentation and accountability.[4,5]

Creep fluids can be limited by avoiding or restricting sodium and chloride intake, stopping maintenance when daily fluid needs are already covered, switching to oral drugs or hypercaloric feeding, or administering antibiotics as a bolus rather than via a small infusion bag. The prevention, care and cure of fluid accumulation syndrome is summarised in Table 1.

Surveys have demonstrated gaps in knowledge regarding appropriate fluid prescribing among healthcare providers, with correct responses ranging from just 8% to 46%.[8,9]

International studies, such as those conducted in Denmark on the issuing of isotonic solutions, highlight the inappropriate use of saline.[10] In this study, 67% of all isotonic fluid administered was saline while in medical departments this was almost 80%.[10]

By contrast, a study in Scotland has shown positive trends in fluid use, with a shift towards balanced crystalloids and reductions in abnormal saline use over time after implementation of the National Institute for Health and Care Excellence (NICE) guidance and fluid stewardship.[11,12]

In Belgium, data show that over 14 million litres of fluids are administered annually, averaging 7.15 L per patient or 1 L per day. Subtracting nutrition, drug dilutions, and other sources of fluid creep still results in approximately 4.4 L per patient and 0.6 L per day, consistent with findings from Scotland.[13]

Hospitals can aim to achieve similar results by introducing balanced solutions and reducing unnecessary fluid administration.

Ultimately, IV fluids should not be regarded as harmless bags of water but as medications with specific indications and contraindications. By implementing evidence-based frameworks and embracing fluid stewardship, we can improve patient outcomes, prevent complications and ensure the rational use of fluids in clinical practice.

The 10D framework

The 10D framework addresses misconceptions about fluid therapy, such as the assumption that all septic patients are

TABLE 1

Prevention, care and management of fluid accumulation syndrome

Prevention	Care	Cure
Fluid restriction: Aimed at restricting the daily amount of (IV) fluids administered because of fluid retention	Monitoring • Basic monitoring with arterial and central venous line in case of shock • Perform baseline transthoracic (or transesophageal) echocardiography	Withdraw fluid: Reducing the dose or completely stopping previously started IV fluids
Restrict resuscitation fluids, only give when: 1. Shock (acute circulatory failure) 2. Tissue hypoperfusion 3. Presence of fluid responsiveness 4. Absence of fluid tolerance 5. No risk for FAS	Monitoring fluid accumulation • Laboratory results, urea and electrolytes, and blood gas analysis with base excess and lactate • Baseline and daily body weight and fluid balance	De-escalation: Withhold initiating extra fluids or lower the dose or speed of administration of previously started fluid therapy due to improvement in the clinical condition of the patient. Resuscitation: Stop fluid resuscitation Maintenance: Evaluate and potentially reduce Creep: Minimise fluids with medication
Withhold fluid: The decision not to start intravenous fluids because they are not indicated or potentially harmful (e.g., no maintenance fluid when not needed)	Monitoring FAS • Assess fluid unresponsiveness • Monitor for risk for fluid accumulation • Assess for the impact of fluid accumulation on end-organ function	De-resuscitation: Correction of fluid overload or fluid accumulation (syndrome) by the active removal of the excess fluids using pharmacological (e.g., diuretics) or non-pharmacological (e.g., dialysis with net ultrafiltration) methods
Minimise fluid creep Limit drug dilution Use glucose instead of saline Administer drugs as bolus rather than small infusion	Early vasopressors (norepinephrine, terlipressin, vasopressin)	Late goal directed fluid removal (LGFR): Active fluid removal by means of diuretics or renal replacement therapy with net ultrafiltration. This is referred to as de-escalation or de-resuscitation
Use human albumin 20%	Lower intra-arterial pressure	Diuretics: Furosemide stress test Loop diuretic (furosemide, bumetanide): high dose and continuous furosemide or bumetanide: bolus 1 mg/kg
Use hypertonic solutions, small volume resuscitation with 4ml/kg	Improve abdominal perfusion pressure Improve renal perfusion pressure	Combination therapy • Carbonic anhydrase Inhibitors • Thiazide (indapamide): • Potassium sparing (spironolactone): aldosterone receptor antagonist
Metabolic optimisation • Limit IV fluid intake when oral fluids possible • Oral fluids/drugs when possible • Use concentrated enteral formulae • Use KDIGO kidney care bundles • Avoid and limit sodium intake • Avoid and limit chloride intake	Vasodilators: Calcium antagonists, angiotensin-converting enzyme inhibitors	Other combinations: • Albumin + furosemide • Positive end-expiratory pressure (PEEP) increases alveolar fluid clearance • PEEP + albumin + Lasix: Complementary and synergistic effect to clear excess lung water and achieve negative fluid balance
	Inotropes: Dobutamine , milrinone (especially when right heart pressure increased	Slow-extended daily dialysis or continous venovenous haemofiltration with ultrafiltration
		Venous compression stockings

hypovolaemic or that fluid responsiveness always necessitates administration.[14]

The framework comprises the following elements:

- D1 (Definitions)
- D2 (Diagnosis)
- D3 (Distribution)
- D4 (Drug selection)
- D5 (Dose)
- D6 (Duration)
- D7 (De-escalation)
- D8 (Documentation)
- D9 (diligence)
- D10 (discussion).[14]

Definitions

It is crucial to establish clear and universal definitions for various types of fluids and their uses. This includes differentiating between maintenance fluids (to cover daily needs), resuscitation fluids (to restore shock and save lives), replacement fluids (to cover ongoing losses), and nutrition fluids (to cover daily caloric needs). It also includes definitions for volume status and fluid responsiveness.[15]

Diagnosis

Accurate diagnosis of a patient's fluid volume status and fluid requirements based on their clinical condition is essential. This involves identifying underlying pathologies and co-morbidities, as well as assessing the extent of fluid deficits and evaluating fluid responsiveness and unresponsiveness.

Distribution

Understanding the distribution of fluids across various compartments within the body is essential for tailoring fluid therapy. This encompasses knowledge of intravascular, extravascular, interstitial, intracellular and extracellular fluid spaces. The concepts of osmolality and tonicity (or effective osmolality) are equally important. It is crucial to recognise that all fluids ultimately move to the interstitial space.

The volume-expanding effect of 1 L of crystalloid after one hour is 25%; for hypotonic solutions such as glucose or

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dextrose 5%, it is 8%, and for colloids, it is 100%. However, the half-life is context-sensitive, and in cases of severe shock or hypotension (e.g., during surgery or following anaesthesia induction), the volume expansion effect of crystalloids and colloids may be comparable, provided they are infused while shock persists.[2,16]

Drug
Fluids are drugs, and they should only be administered when necessary and with caution. The best fluid may well be the one that was not used unnecessarily. In line with the well-known concept of antibiotic stewardship, we should also consider fluid stewardship.[17] Selecting the appropriate type of fluid (crystalloid or colloid, isotonic, hypotonic, or hypertonic, balanced or unbalanced) should depend on the patient's condition and treatment objectives.

Dose
Determining the appropriate volume and rate of fluid administration relevant to the indication in order to achieve the desired therapeutic effect without causing harm.

Duration
Defining the suitable length and duration of fluid therapy according to the patient's continuous needs and response to treatment.

De-escalation
Reducing or discontinuing fluid therapy when it is no longer necessary (e.g., when the patient can consume oral fluids or when shock has resolved) to prevent fluid overload, FAS and associated complications.

Documentation
Ensuring comprehensive documentation of all aspects of fluid therapy, including the type, volume, rate, and patient response. It is all about administering the correct fluid, in the appropriate dosage, at the right rate, to the right patient at the right time.

Diligence (stewardship)
Implementing thorough oversight and management of fluid therapy practices to optimise patient outcomes and minimise risks entails a plan-check-act cycle that monitors key performance indicators.

Discussion
Engaging in multidisciplinary discussions and reviews of fluid therapy practices (including adverse effects and IV fluid-related complications) to ensure continuous improvement and adherence to best practices. This implies change management and transformation and needs authentic leadership to tackle human factors and resistance to change (see article later in the handbook).

Together, the 10 Ds form a systematic approach to fluid management that should be implemented at the bedside.[14]

Conclusion
Fluid stewardship signifies a vital change in the management of IV fluids within clinical practice. Although often seen as innocuous, IV fluids must now be acknowledged as medications that necessitate careful consideration of indications, contraindications, potential complications, and adverse effects.

The adoption of the 10D framework provides a structured, evidence-based approach to fluid management, addressing key challenges such as fluid creep, inappropriate prescriptions and knowledge gaps among healthcare providers.

By emphasising the use of balanced solutions for resuscitation, minimising unnecessary maintenance fluids, limiting creep fluids (small boluses rather than mini-bags), restricting sodium and chloride intake, and prioritising oral hydration whenever possible, hospitals can significantly reduce fluid-related complications such as AKI, electrolyte imbalances, acid-base disturbances, and abdominal compartment syndrome.

The implementation of a fluid stewardship programme begins with the establishment of a multidisciplinary core fluid team,[18] baseline assessments, knowledge testing, and clear objectives (see further in the handbook). Success hinges on continuous education, regular audits, and proactive adjustments based on emerging evidence and feedback.

Ultimately, effective fluid stewardship ensures that IV fluids are used wisely, enhancing patient outcomes, lowering costs, and promoting a culture of safety and accountability. This transformative approach raises fluid therapy from routine practice to a cornerstone of high-quality, evidence-based care. Institutions that adopt this framework are poised to achieve measurable improvements in both clinical outcomes and operational efficiency.

References
1 Vandervelden S, Malbrain ML. Initial resuscitation from severe sepsis: one size does not fit all. Anaesthesiol Intensive Ther 2015;47 Spec No:44–55.
2 Malbrain MLNG et al. Principles of fluid management and stewardship in septic shock: It is time to consider the four D's and the four phases of fluid therapy. Annals Intensive Care 2018;8(1):66.
3 Pfortmueller CA et al. Fluid accumulation syndrome in sepsis and septic shock: pathophysiology, relevance and treatment – a comprehensive review. Ann Intensive Care 2024;14(1):115.
4 Van Regenmortel N et al. Fluid-induced harm in the hospital: look beyond volume and start considering sodium. From physiology towards recommendations for daily practice in hospitalized adults. Ann Intensive Care 2021;11(1):79.
5 Van Regenmortel N et al. Maintenance fluid therapy and fluid creep impose more significant fluid, sodium, and chloride burdens than resuscitation fluids in critically ill patients: a retrospective study in a tertiary mixed ICU population. Intensive Care Med 2018;44(4):409–17.
6 Van Regenmortel N et al. Effect of sodium administration on fluid balance and sodium balance in health and the perioperative setting. Extended summary with additional insights from the MIHMoSA and TOPMAST studies. J Crit Care 2022;67:157–65.
7 Van Regenmortel N et al. 154 compared to 54 mmol per liter of sodium in intravenous maintenance fluid therapy for adult patients undergoing major thoracic surgery (TOPMAST): a single-center randomized controlled double-blind trial. Intensive Care Med 2019;45(10):1422–32.
8 Nasa P et al. Intravenous fluid therapy in perioperative and critical care setting-Knowledge test and practice: An international cross-sectional survey. J Crit Care 2022;71:154122.
9 Wuyts SCM et al. Interdisciplinary knowledge gaps on intravenous fluid management in adult patients: Survey among physicians and nurses of a university hospital. J Eval Clin Pract 2022;28(4):599–606.
10 Ellekjaer KL et al. Issuing of isotonic crystalloid solutions to Danish public hospitals in 2021 – A retrospective nationwide observational study. Acta Anaesthesiol Scand 2023;67(2):177–84.
11 McDougall M et al. Introducing NICE guidelines for intravenous fluid therapy into a district general hospital. BMJ Open Qual 2022;11(1).
12 Padhi S et al. Intravenous fluid therapy for adults in hospital: summary of NICE guidance. BMJ 2013;347:f7073.
13 International Fluid Academy. An introduction to fluid stewardship - A Belgian perspective. https://fluidacademy.mn.co/posts/an-introduction-to-fluid-stewardship-a-belgian-perspective (accessed February 2025).
14 Malbrain MLNG et al. Rational Use of Intravenous Fluids in Critically Ill Patients. Malbrain MLNG (ed). Berlin: Springer Cham 2024:595pp.
15 Malbrain MLNG et al. Terms and Definitions of Fluid Therapy. In: Malbrain MLNG et al (eds). Rational Use of Intravenous Fluids in Critically Ill Patients. International Fluid Academy Core Critical Care. Berlin: Springer Cham 2024:3–46.
16 Malbrain MLNG et al. Intravenous fluid therapy in the perioperative and critical care setting: Executive summary of the International Fluid Academy (IFA). Ann Intensive Care 2020;10(1):64.
17 Malbrain MLNG et al. It is time for improved fluid stewardship. ICU Management and Practice. 2018;18(3):158–62.
18 Malbrain M et al. Multidisciplinary expert panel report on fluid stewardship: perspectives and practice. Ann Intensive Care 2023;13(1):89.

Implementing and mandating change: inspiring future practice

The success of fluid stewardship programmes relies on coordinated interventions, including strategy and policy development, the design of overarching systems, and the encouragement of collaboration and multidisciplinary working. In this context, Alan Timmins outlines these steps and explains how the pharmacist plays a central role in the fluid stewardship team

Alan Timmins MSc MRPharmS (Consultant) FFRPS
Critical care pharmacist, Victoria Hospital, Kirkcaldy, Scotland

In many respects, fluid stewardship can be regarded as a form of ongoing quality improvement (QI).[1] The organisation has defined what constitutes cost-effective and safe practice to ensure optimal clinical outcomes for patients; this should include systems to achieve these objectives.

Everyone involved must understand these goals and how they can be demonstrated to be achieved. Frequently, 'stewards' or 'champions' inspire all staff to collaborate towards fulfilling these objectives. Such outcomes seldom occur by chance, so significant effort is typically required to ensure success.

What is required initially?

Before embarking on a fluids programme, considerable background work is required to clarify its implications for the organisation, identify who holds ultimate responsibility for the outcomes, and define the programme's vision. At this stage, alongside appointing a clinical lead, it is crucial to secure executive buy-in from the organisation. This support can be vital as the programme progresses, ensuring that there are managerial inputs or resources, potentially financial, to help overcome barriers and challenges.

Agree on guidelines to optimise use

The next stage is to agree on the guideline that clinicians will use to optimise fluid use. This part of the process needs to be wide-ranging, involving all personnel likely to have a view on the subject to ensure a feeling of ownership, which is likely to aid success. Once agreed upon, the guideline needs to be made available to all potential prescribers and those likely to be involved in the administration of IV fluids in the organisation.

At this point, an investment of time and thought can produce a good return on investment and greater success if a clear and convenient resource can be produced. In the past, this would typically take the form of a paper copy, often produced as something that can be kept in the pocket, so available for reference at the point of prescribing. In the last few years, clinicians have become increasingly reliant on mobile phones as an information source, and there are many apps available to assist with prescribing.[2] The advent of electronic prescribing has opened up possibilities of including links to guidelines as part of the prescribing process to provide real-time interaction.

Education is key

Specific education is vital to ensure those prescribing or administering fluids understand the things that will make a difference. It has been recognised for some time that undergraduate training in IV fluids for medics, nurses and pharmacists is often insufficient,[3] while postgraduate training is typically inconsistent and often 'on the job'. In-depth training will most likely be restricted to those with a particular interest in the topic. It is therefore important to ensure in-house training is available if required, to ensure staff have the necessary knowledge to utilise the guideline appropriately.

If possible, the training should be tailored to reflect the functions of different groups, whether prescribers, nurses or pharmacists. However, knowledge of the responsibilities of the other groups is important so that deviations from the expected actions can be challenged. The educational programme needs to be ongoing, providing initial training to new hires and top-up or refresher training to all staff on a recurrent basis.

Equipment and documentation requirements

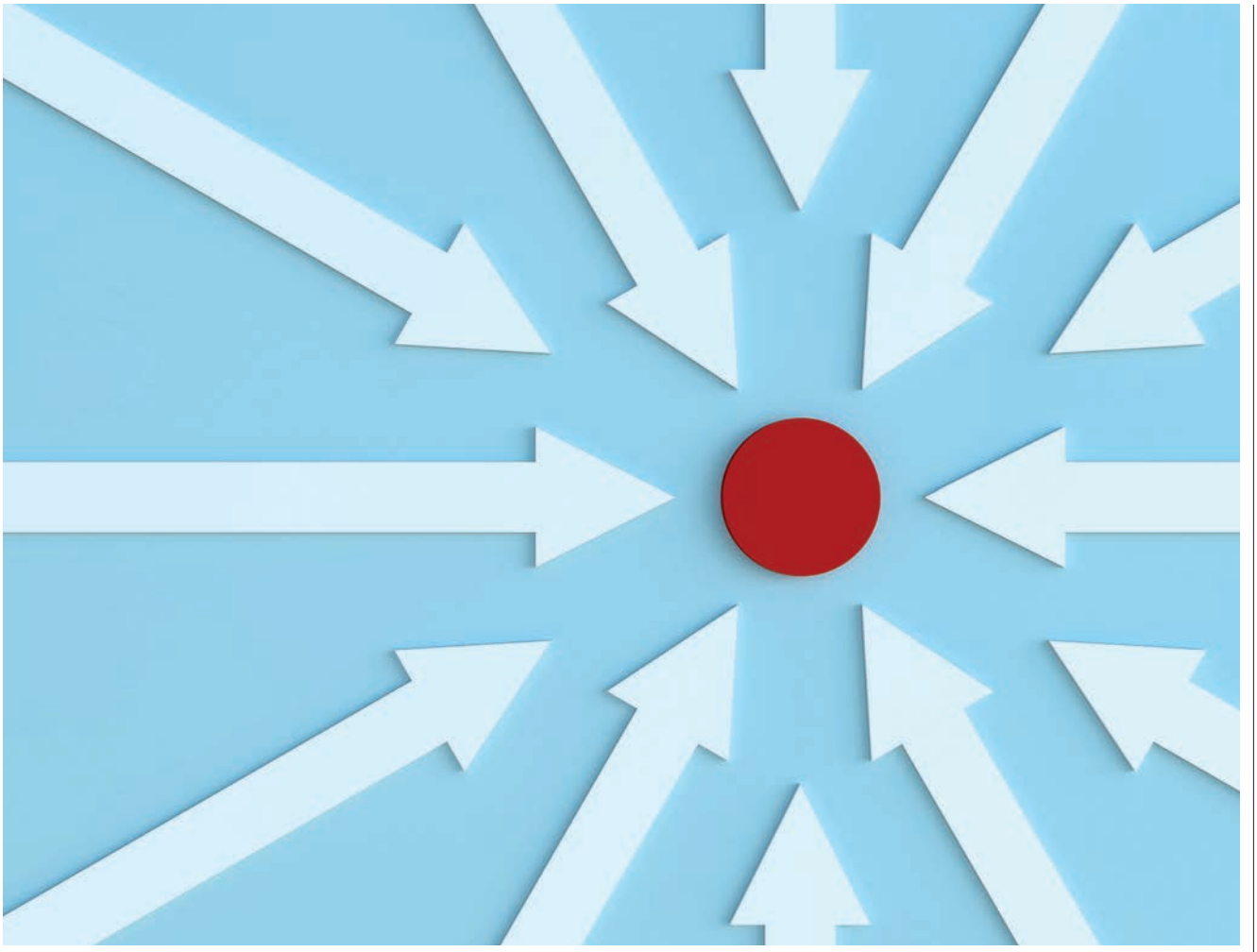
In addition to suitably trained staff, appropriate equipment for administration (including training and maintenance) and for documenting treatment is essential.

In many organisations, infusion devices will be employed to aid accurate administration. This necessitates effective management of the devices to ensure their availability when needed, along with systems to oversee the procurement and maintenance of suitable devices. Consequently, collaboration with medical physics departments is crucial for success.

Standardisation of consumables for administration is also significant as it simplifies training and often promotes cost-effective practices. Therefore, the cooperation of procurement teams is vital.

Increasingly, many organisations are now utilising dose error reduction software (DERS), often referred to as 'drug libraries'. This software is installed on the infusion device, allowing limits to be imposed on infusion parameters for selected drugs, thereby preventing both over- and under-infusion, and enhancing patient safety.[4]

A common refrain in fluid stewardship programmes is that 'Fluids are Drugs', emphasising that the prescribing of IV fluids demands as much care and attention as the prescribing of digoxin or amoxicillin, including administering the correct amount, at the correct rate, and at the right time. Establishing the parameters for DERS within an organisation necessitates excellent coordination between prescribers, nurses and pharmacists, and sufficient resources must be allocated to this process to ensure its success. One often overlooked aspect is that a wireless connection is typically required to effectively



transfer data between the devices and the central control unit. Thus, the involvement of the organisation's IT department is invaluable.

Appropriate and suitable documentation is essential to ensure safe and effective treatment, and well-designed documents can be valuable in facilitating the review and audit of what has been prescribed and administered.

As noted above, the prescribing of fluids is increasingly conducted electronically. Consequently, there is a greater opportunity to ensure that it is executed correctly, as most inputs can be made mandatory and adhere to certain parameters. Administration rates and fluid balance are not yet routinely recorded electronically. Electronic systems provide the potential for reminders to ensure that regular checks are documented and can also carry out ongoing calculations, which may highlight suboptimal progress and consequently offer automatic warnings of deterioration.

Electronic records are more likely to be complete and legible than hard copies, so they are potentially more useful for reviewing treatment. They may often be suitable for analysis electronically rather than laborious manual review. If manual documentation is used, every effort should be made to make the page as simple as possible and easy to complete. Data analysts, quality improvement specialists, or sometimes clinical governance staff can be very helpful in advising on how to document and analyse information.

So, in addition to the core personnel of medics, nurses and pharmacists, there are a great many other groups that are important to support fluid stewardship, including medical physics staff, data analysts, QI specialists, clinical governance staff and training specialists, both for educating about the clinical use of fluids and for using the infusion devices.

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What to review and what it means

To evaluate the programme and promote improvements, a series of audits will be necessary to produce relevant data as indicators of success. The suite of audits will develop over time, from the planning phase of the programme, through its implementation, to its established state.

It is important to clarify the main aims of implementing a stewardship programme and relate these to what can be assessed. A baseline assessment of current practices will help quantify existing problems. This includes examining issue patterns, the variety of fluids used, adherence to the proposed guidance, and the effectiveness of current documentation. Additionally, an evaluation of the current levels of knowledge regarding fluids will reveal the extent of educational activities likely required to ensure successful implementation. This should encompass medics, nurses and pharmacists. Furthermore, it should also become clear whether the appropriate individuals are involved in the team.

An audit is a vital component of any QI project. As part of fluid stewardship, there are three broad aspects to consider: processes, systems and outcomes.

The processes aspect involves auditing the assessments conducted to ensure that appropriate prescriptions are accurate and complete.

The systems aspect requires an examination of the

proper supply and use of fluids according to local guidelines, ensuring that usage patterns align with expectations.

The final aspect pertains to actual patient outcomes, which may be more challenging to collect. This aspect is crucial to fluid stewardship, as it aims to ensure optimal patient outcomes and may involve monitoring adverse events, the development of acute kidney injury or electrolyte disturbances, and analysing morbidity and mortality rates.

Boxes 1–3 summarise potential topics for auditing prescribing, supply, usage and assessing outcomes.

Collecting data on patient outcomes is likely to be the most challenging, even when electronic patient records are accessible. To evaluate what occurred in each case, the actual records must be reviewed. Thus, it may be wise to concentrate on ensuring optimal performance in the other areas, as without strong performance there, appropriate treatment is unlikely to be provided.

The figures for fluid use, and particularly the derived values (e.g., volume/ patient), will be specific to the institution or unit involved. As they depend on the case mix and patient acuity, they are of limited value in comparison to other units. However, once a baseline is established, any movements in the values may indicate a change in practice.

Pharmacists are ideal fluid stewards

Pharmacists have oversight of the supply of fluids to clinical areas, so they are ideally positioned to implement usage review programmes. Typical patterns of issue of common fluids to individual ward areas or to an entire institution can be established as a baseline to look for changes in practice in the context of agreed guidelines for use. Examples are available from Fife (UK)[5] and Belgium.[6]

Pharmacists can also monitor the cost of treatment and look to minimise unnecessary use and waste. The environmental impact of plastics used for infusion bags and administration sets contributes a large proportion of the significant CO_2 emissions due to pharmaceuticals, which account for around 18% of the total emissions in healthcare.[7]

Where pharmacists are working on wards and active at the point of prescribing, they are in a position to challenge prescribing and ensure appropriate documentation, so they should make good fluid stewards. Seeing what is happening, they may suggest where audits are required and could direct audits at the team level to help improve practice.

Audit results can provide pointers for educational needs. Pharmacists typically follow guidelines and are keen to teach the preferred lines. Undergraduate education in IV fluids is known to be poor, so it is necessary to take all opportunities to improve this, whether through planned events or impromptu opportunities.

Conclusion

Fluid stewardship aims to optimise the clinical outcomes of IV fluid administration while minimising adverse effects. This requires good theoretical and practical knowledge among those delivering treatment, clear processes and appropriate monitoring of what is happening.

Implementing and mandating change is vital to ensuring systems are in place to detect problems, learn from them, and improve future practice. A good programme should also produce other benefits, such as reduced resource use (cost savings) and satisfaction for participants.

Pharmacists are well positioned to contribute to fluid stewardship programmes, whether by providing usage data, monitoring prescribing and outcomes in the wards, or seizing opportunities to promote optimal use. Ideally, they should take lead roles as part of the multidisciplinary team. In some instances, a suitably qualified and motivated pharmacist may serve as the clinical lead for IV fluids within an organisation.

BOX 1

Possible topics for auditing the prescribing process

- Availability of patient weight (%)
- Availability of blood results, especially urea and electrolytes (%)
- Completed fluid balance chart (%)
- Complete and legal prescription (%)
- Appropriate route for providing fluids (%)
- Adherence to guideline (%)

BOX 2

Potential topics for auditing supply and usage of fluids

- Fluid choices indicate adherence to fluid guidance (no non-recommended fluids)
- Total consumption of IV fluids per month or year
- Consistent ratio of issues of recommended fluids
- Consistent ratio of balanced crystalloid to 0.9% sodium chloride infusion
- Volume of fluid per admission, or bed day
- Use of appropriate bag size (e.g., ratio of 500 mL to 1000 mL)
- Cost of issues of fluids per month or year
- Incidence of administration problems, e.g., lack of infusion device

BOX 3

Potential topics for auditing outcomes

- Incidence of acute kidney injury
- Incidence of clinically significant fluid overload
- Incidence of clinically significant electrolyte
- Incidence of adverse event reports
- Analysis of morbidity and mortality

References

1 Wong A et al. Introduction to Fluid Stewardship. In: Wong A et al (eds) Rational Use of IV Fluids in Critically Ill Patients. Springer 2024:545–65.

2 Healthcare Improvement Scotland. Right Decision Service. IV fluids prescribing – calculator and guidance. https://rightdecisions.scot.nhs.uk/iv-fluids-prescribing-calculator-and-guidance/?organization=centre-for-sustainable-delivery (accessed February 2025).

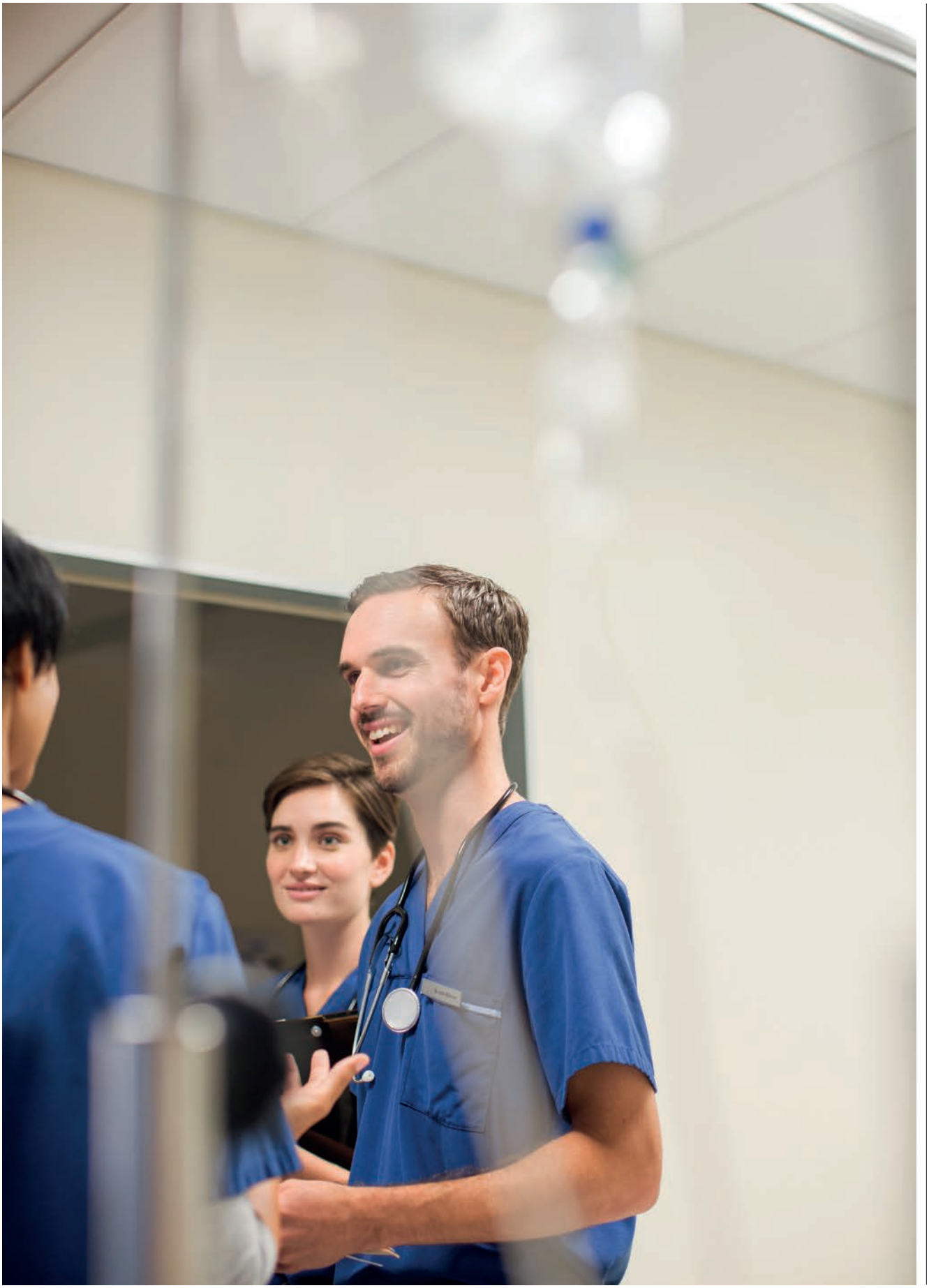
3 McCrory RFR et al. Learning to prescribe intravenous fluids: a scoping review. Perspect Med Educ 2017;6(6):369–79.

4 Health Services Safety Investigations Body. Investigation report: Procurement, usability and adoption of 'smart' infusion pumps. www.hssib.org.uk/patient-safety-investigations/procurement-usability-and-adoption-of-smart-infusion-pumps/investigation-report/ (accessed February 2025).

5 McDougall M et al. Introducing NICE guidelines for intravenous fluid therapy into a district general hospital. BMJ Open Quality 2022;11:e001636.

6 International Fluid Academy. An Introduction to Fluid Stewardship – A Belgian perspective. https://cms.fluidacademy.org/component/zoo/item/an-introduction-to-fluid-stewardship-a-belgian-perspective.html (accessed February 2025).

7 Hunfeld N et al. Circular material flow in the intensive care unit – environmental effects and identification of hotspots. Intensive Care Medicine 2023;49(1):65–74.



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Fluid stewardship in action: a case study

East Lancashire Hospitals in the UK have taken a holistic approach to fluid stewardship, encompassing storage, range, and 'volume' of stockholding on wards, education and audit. This case study describes the practical steps taken, the issues encountered, the solutions employed to address those issues, and the steps needed to refine the processes further

Alistair Gray BSc (Hons) DipClinPharm MRPharmS
Clinical Services Lead Pharmacist, East Lancashire Hospitals NHS Trust, UK

In 2000, the National Confidential Enquiry into Perioperative Deaths reported that up to one in five patients who had received IV fluids suffered from complications or morbidities due to inappropriate prescribing or administration.[1]

Fluid prescribing can and does harm, but locally, it is rare for an incident report to be submitted due to a poor fluid prescription. Typically, clinical staff manage the consequences of poor fluid prescriptions, such as over- or underhydration and unbalanced electrolytes, and do not usually reflect that the situation could have been avoided with more effective fluid prescribing.

The fluid stewardship committee

A fluid stewardship committee is an essential body that should comprise at least a consultant, a senior nurse and a senior pharmacist. Our committee was formed in 2019 and included a quality and safety lead, along with practice educators.

We met monthly until just before the Trust launched an electronic patient record (ePR) in June 2023, when regular personnel changed roles within the Trust,which lead to a hiatus. The committee was reinstated in early 2025 with the same objective of ensuring that fluid prescribing in adults is in line with the National Institute for Health and Care Excellence (NICE) clinical guidance 174 (NICE CG174).[2]

The triumvirate of a consultant, a nurse, and a pharmacist represents the 'holy trinity' of ensuring that the Trust's fluid prescribing and administration policy is well-defined and that broader stewardship (governance) arrangements are in place. However, without audit data on the adherence of prescriptions to NICE CG174, the committee will be unable to assure the Trust that fluid prescriptions are effective and being administered appropriately.

Before the ePR, point prevalence audits indicated poor adherence.[2] After the ePR implementation, it took around 18 months before we were able to audit electronic fluid prescriptions.

Prescribing by indication

NICE CG174 refers to 'The 5 Rs', i.e., fluid resuscitation, fluid replacement, fluid redistribution and routine maintenance fluid and presents algorithms for each element covering assessment and prescribing. The fifth 'R', i.e., reassessment, underpins them all.[3]

One of the committee's tasks was translating these algorithms into practical prescribing guidance, using Trust formulary fluid choices to make it easy for prescribers to consistently create effective prescriptions.

Each indication is now covered below.

Fluid resuscitation

NICE recommends administering a 500 mL bolus dose of crystalloid solution (containing sodium levels between 130–154 mmol/L) in under 15 minutes. Prescribers may not be aware of which fluids meet this criterion.

Sodium chloride 0.9% (containing sodium at 154 mmol/L) could be suitable, but within our Trust, we utilise Plasma-Lyte 148 fluid.[4] This fluid complies with the NICE guidelines (the sodium concentration is 140 mmol/L) and is classified as a 'balanced crystalloid'. This designation indicates that it contains sodium, potassium and chloride in proportions more akin to that of extracellular fluid. When administered intravenously, it has fewer adverse effects on acid–base balance.[5]

We use infusion pumps with a maximum infusion rate of 1200 mL/hour, which means they cannot deliver 500mL in less than 15 minutes – it takes 25 minutes. An additional consideration came from the full NICE CG174 guideline,[6] which states that people with a history of congestive cardiac failure, chronic kidney disease, and individuals weighing less than 50 kg are at risk of fluid overload with a 500 mL bolus prescription. The committee recommended a 250 mL bolus prescription for these groups, which an infusion pump would deliver in 12.5 minutes.

The reassessment period in fluid resuscitation occurs after the bolus dose has been administered. NICE permits up to four boluses (2000 mL if 500 mL boluses are used) before a senior consultant should review the patient.

In our system (see example in Figure 1), the prescriber need only choose between a weight-adjusted dose (250 mL for those <50 kg, or 500 mL for those ≥50 kg) and a 250 mL dose for patients with chronic kidney disease or congestive heart failure.

Fluid redistribution

Fluid redistribution is the trickiest concept within NICE CG174 to grasp and manage. Internal fluid redistribution can occur in critically ill patients, those with sepsis, post-operative patients, patients with severe renal, liver or cardiac problems and the malnourished.

NICE does not provide guidance on calculating dose volume or infusion duration. To obtain practical prescribing advice, the fluid stewardship committee has adopted the principles of

FIGURE 1

Fluid resuscitation guidance and prescription

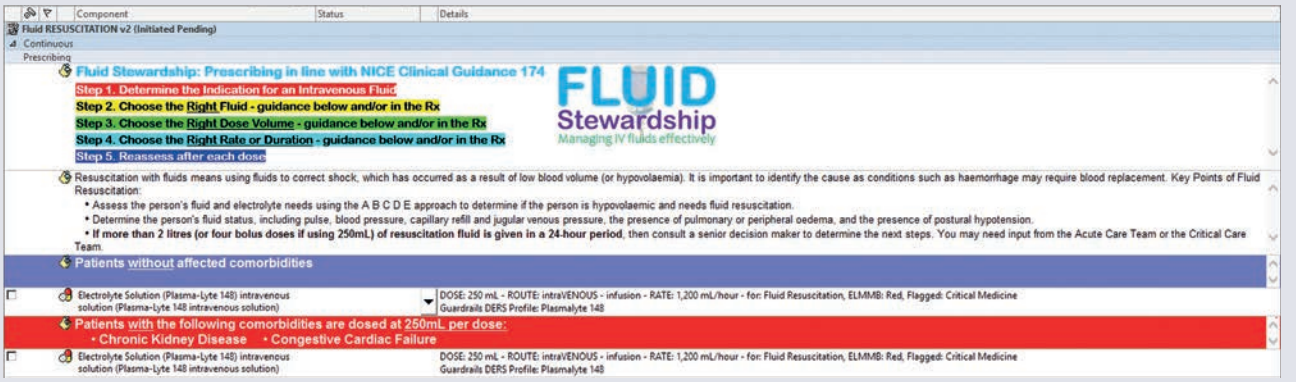
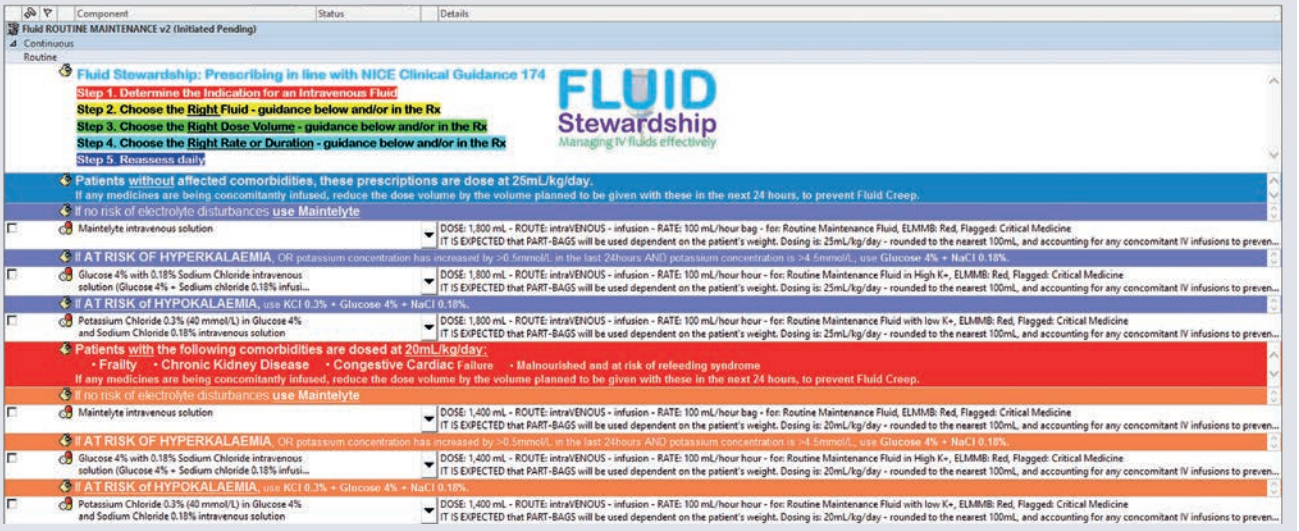


FIGURE 2

Fluid routine maintenance guidance and prescription



the WATERFALL Trial,[7] which focused exclusively on acute pancreatitis, and recommends dosing options of 1 mL/kg/hour, 1.5 mL/kg/hour, or 2.0 mL/kg/hour, depending on the patient's illness severity, with higher dosing recommended for the 'sickest' patients, including those with systemic inflammatory response syndrome. To prevent inadvertent fluid overload, our guidance suggests a reassessment window of four to six hours, with a shorter duration for higher volume doses.

Fluid replacement

In an ePR, the fluid balance chart indicates a current fluid deficit for the last 24 hours, with the goal of fluid replacement being to replenish that deficit. Alternatively, one can predict the replacement volume for the upcoming 24 hours based on historical losses while considering any fluids already administered, such as intravenous antibiotics, to avoid 'fluid creep', where such fluids are not included in calculations, leading to overhydration.[8]

In practice, we recommend rounding the determined volume to the nearest 100 mL. When losses are gastric, we use sodium chloride 0.9% to mitigate the additional chloride loss from this source. The reassessment period is daily, as losses can be dynamic.

In our system, the prescriber is additionally asked to state the number of 1000 mL bags that will be used to deliver the dose volume; this aids administration in our ePR.

Routine maintenance fluid

If a person can absorb fluids enterally, i.e., by mouth or feeding tube, they should be allowed to drink or be given water. Intravenous fluids should only be administered to individuals whose needs cannot be met enterally, and a switch to oral hydration should occur as soon as possible.

NICE CG174 recommends a daily fluid intake of 25–30 mL/kg. In practice, we suggest 25 mL/kg/day rounded to the nearest 100 mL, with a maximum of 2.4 L per day to prevent fluid overload in obese patients. This dosage is reduced to 20 mL/kg/day for patients who are frail, malnourished, have renal impairment, or are experiencing congestive cardiac failure, again to prevent fluid overload.

Adults also need around 1 mmol/kg of potassium, sodium and chloride, and 50–110 g of glucose to limit starvation

ketosis (N.B. this amount of glucose does not fulfil a person's nutritional requirements). There is currently no commercially available fluid that exactly matches these needs. In the past, we recommended sodium chloride 0.18% with glucose 4% and potassium chloride 0.15%, but on a paper prescription, this was very difficult to write accurately, so we switched to Maintelyte.[9] This offers a blend of electrolytes in line with NICE's recommendations and is more convenient to prescribe in written form. We continued using it after switching to the ePR.

Alternative prescribing options are available if a patient is at risk of hypokalaemia or hyperkalaemia, with varying amounts of potassium included or excluded, respectively. If a patient clinically presents with hypokalaemia or hyperkalaemia, the specific Trust electrolyte disturbance guidance should be adhered to instead.

In this case in our system (see example in Figure 2), the prescriptions are pre-dosed using weight filters, and prescribers are instructed to subtract the volume of any intravenous drug infusions planned to be given to prevent fluid creep.

Education and audit

Foundation year one (FY1) doctors receive a fluid prescribing module as part of their induction. Feedback from the FY1s prior to introducing our ePR indicated that they struggled to prescribe in accordance with NICE guidelines in practice, as senior prescribers would articulate the prescriptions they desired, with established prescribing habits taking precedence over NICE. Additionally, conducting point prevalence audits proved challenging, as the indication for the fluid – essential for determining whether the appropriate fluid was selected – was often not documented.

Since the introduction of the ePR, fluids cannot be prescribed without first selecting the indication; however, even with the guidance outlined above, dosing remains in the hands of the prescribers and depends on their adherence to that guidance. Finding the capacity to interrogate our e-prescribing data proved challenging until November 2024.

We had agreed with Lancaster University's School of Medicine to pilot a seven-week selective in advanced medical practice (SAMP) with a fifth-year medical student. In addition to giving the student an insight into clinical informatics, fluid stewardship would form part of the clinical element of this experience, with a focus on routine maintenance fluid prescribing.

The findings revealed that most prescribers did not adhere to the prescribing guidance, and in fact, of the 83 randomly selected patients, only three had dose volumes that matched NICE CG174. In most instances, 1000 mL of fluid was prescribed, equating to a single bag. Although not fully explored, comments from some prescribers suggest that nurses request (whole) 'bags of fluid' instead of recognising the tailored nature of dosing in routine maintenance.

Changing the paradigm

Clearly there is unwarranted variation in prescribing habits from what NICE CG174 recommends. At this stage it is tricky to determine if any harms have occurred from this deviation, but it has led to several actions.

First, this approach using a SAMP student has proven successful and will soon be repeated to explore other aspects of fluid prescribing. Our initial student will provide feedback to Lancaster University regarding the necessity to bridge the gap between teaching the physiology of fluid management and the practical application of fluid prescribing, which is frequently relegated to the 'hidden curriculum', with doctors learning how to prescribe fluids from the previous year's cohort and others within a hospital.[10]

What's required next?

The Fluid Stewardship Committee has recently been reinstated as a subgroup of our Medicines Safety and Optimisation Committee to ensure that fluid stewardship functions effectively.

In practical terms, we need to change the paradigm of prescribers so they prescribe in accordance with NICE CG174. This is essential for nurses to understand how to manage prescriptions with dose volumes that do not equate to a single, whole bag of fluid, and for pharmacists to know how to effectively screen fluid prescriptions. Achieving this will entail developing additional reports from the ePR, supporting future SAMP students in delving deeper into the data, and finding ways to educate both new and existing prescribers, nurses, and pharmacists on becoming proficient fluid stewards.

References

1 National Confidential Enquiry into Perioperative Deaths. The 2000 Report of the National Confidential Enquiry into Perioperative Deaths. www.ncepod.org.uk/2000report3/TaNfull.pdf (accessed February 2025).

2 National Institute for Health and Care Excellence. Intravenous fluid therapy in adults in hospital – clinical guideline 174 [CG174]. www.nice.org.uk/guidance/cg174 (accessed February 2025).

3 National Institute for Health and Care Excellence. Algorithms for IV fluid therapy in adults. www.nice.org.uk/guidance/cg174/resources/intravenous-fluid-therapy-in-adults-in-hospital-algorithm-poster-set-191627821 (accessed February 2025).

4 Plasma-Lyte 148 (pH 7.4) solution for infusion SmPC. www.medicines.org.uk/emc/product/1795/smpc (accessed February 2025).

5 Semler MW, Kellum JA. Balanced Crystalloid Solutions. Am J Respir Crit Care Med 2019 Apr 15;199(8):952–60.

6 National Institute for Health and Care Excellence. Intravenous fluid therapy in adults in hospital – clinical guideline 174 [CG174] Methods, evidence and recommendations. www.nice.org.uk/guidance/cg174/evidence/full-guideline-pdf-191667999 (accessed February 2025)

7 Bolado F et al. Early Weight-Based Aggressive vs. Non-Aggressive Goal-Directed Fluid Resuscitation in the Early Phase of Acute Pancreatitis: An Open-Label Multicenter Randomized Controlled Trial (The WATERFALL Trial), Design, and Rationale. Front Med (Lausanne) 2020 Sep 2;7:440.

8 Van Regenmortel N et al. Maintenance fluid therapy and fluid creep impose more significant fluid, sodium, and chloride burdens than resuscitation fluids in critically ill patients: a retrospective study in a tertiary mixed ICU population. Intensive Care Med 2018;44:409–17.

9 Maintelyte solution for infusion SmPC. 2024. www.medicines.org.uk/emc/product/10010/smpc (accessed February 2025).

10 Lempp H, Seale C. The hidden curriculum in undergraduate medical education: qualitative study of medical students' perceptions of teaching. BMJ 2004;329:770.

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